Cellulosic fibre of the Lyocell type

The present invention relates to a cellulosic fibre of the Lyocell type.

Fibres of the Lyocell type are produced by a solvent spinning process, wherein the cellulose is directly dissolved in an organic solvent without the formation of a derivative and the solution is spun. Such fibres are also referred to as „solvent-spun“ fibres. „Lyocell“ is the generic name allocated by BISFA (The International Bureau for the Standardization of man made fibers) for cellulose fibres which are produced by dissolving cellulose in an organic solvent without the formation of a derivative and extruding fibres from said solution by means of a dry-wet spinning process or a melt-blown process. An organic solvent is thereby understood to be a mixture of an organic chemical and water. At present, N-methyl-morpholine-N-oxide is used as an organic solvent on a commercial scale.

In said process, the solution of the cellulose is usually extruded by means of a forming tool, whereby it is moulded. Via an air gap, the moulded solution gets into a precipitation bath, where the moulded body is obtained by precipitating the solution. The moulded body is washed and optionally dried after further treatment steps. A process for the production of Lyocell fibres is described, for instance, in US-A 4,246,221. Lyocell fibres are distinguished by a high tensile strength, a high wet-modulus and a high loop strength.

In a publication „Lyocell – eine vielseitige cellulosische Faser“ in the Lenzinger Berichte 75/96 it is mentioned without any further details that carpets and carpet backs constitute possibilities of application for Lyocell fibres.

In a lecture by W. Feilmair et al. „Funktionalität von Lenzing Lyocell® in Heimtextilien“ at the 5th International Symposium „Alternative Cellulose – Herstellen, Verfahren, Eigenschaften“ in Rudolstadt 2002, a fibre of the Lyocell type having a titre of 6.7 dtex and a cutting length of 60 mm is described.

EP 0 494 851 describes a process for the manufacture of Lyocell fibres, wherein the draft (the ratio of the drawing-off speed of the filament, divided by the nozzle-hole discharge speed) amounts to 1 at the most, or in particular is smaller than 1, respectively.

Conventional fibres of the Lyocell type exhibit a ratio V of the strength of the fibre in the conditioned state FFk to the fibre elongation in the conditioned state Fdk (measured and calculated in accordance with the methods described below in greater detail) of clearly more than 2.2.

Surprisingly, it has now been found that it is possible to provide a Lyocell fibre whose ratio V of the strength of the fibre in the conditioned state FFk to the fibre elongation in the conditioned state Fdk is below 2.2.

Accordingly, the present invention relates to a fibre of the Lyocell type which is characterized in that the ratio V of the strength of the fibre in the conditioned state FFk to the fibre elongation in the conditioned state Fdk amounts to 2.2 or less.

Preferably, the ratio V amounts to 2.0 or less, particularly preferably to 1.8 or less. Furthermore, the ratio V should preferably not amount to less that 1.

Preferably, the fibre according to the invention exhibits a titre of 6 to 25 dtex.

Surprisingly, it has been shown that a balanced ratio between FFk and Fdk is achievable in particular during the manufacture of Lyocell fibres having a higher titre.

It is known to a person skilled in the art that the titre of the fibre depends in particular on the drawing-off speed or on the ratio of the drawing-off speed to the speed at which the spinning dope is discharged from the spinneret, respectively.

It has now been found that, during the manufacture of fibres having a higher titre, a decrease in the ratio between FFk and FdK is observed as the titre increases. Said effect becomes apparent in particular as from a titre of 6 dtex. Extra low ratios V can be achieved when producing fibres having a titre of 7 dtex or more, in particular 12 dtex or more, and preferably 15 dtex or more.

The fibre according to the invention is preferably provided in the form of a staple fibre.

Fibres according to the invention are preferably produced by means of a process wherein the draft assumes a value of more than 1.

It has been found that the fibre according to the invention, in particular when having a higher titre of 12 dtex, 15 dtex or more, is excellently suitable for applications in carpets, textile flooring materials, wall linings and/or decoration materials.

The carpets today on the market are produced largely from the synthetic fibres polyamide and polypropylene and from wool. Mixtures of wool with polyamide and polypropylene are used as well. Fibres such as polyacrylonitrile, polyester and cotton play a secondary role.

Up until the mid-60ies, viscose fibres having a higher titre (f.i. 17 dtex) were also used for carpets besides cotton. However, due to the development of synthetic fibres and their advantages in terms of mechanical resilience, the viscose fibre was completely eliminated from this field.

Various demands are made on carpets. Carpets are used because of a higher living comfort in comparison with smooth floors. For areas subject to less strain, velour carpets according to the tufting method are usually used. For areas subject to higher mechanical strain, loop or felt carpets are used.

A disadvantage of synthetic fibres and wool is their electrostatic charge. Tensions of 7-9 kV are measured in standardized walk tests. Only by appropriate measures, such as by furnishing the fibres with antistatic agents or by incorporating conductive fibres in the carpet structure, an antistatic effect can be achieved and the tension during the walk test can be reduced to below 3 kV. Another problem associated with wool is an infestation by moths, making it necessary that the carpets be treated with toxic insecticides. Polypropylene, on the other hand, has, as a material for carpets, the disadvantage that the fibre is not colourable and printable, whereby only a limited colour palette can be achieved by spin dyeing.

Surprisingly, it has turned out that it is feasible to produce tufting carpets exhibiting excellent mechanical properties from Lyocell fibres having a higher titre of, f.i., 15 dtex, especially in combination with synthetic fibres. In comparison with carpets made from synthetic fibres and/or wool, carpets made from Lyocell fibres exhibit an inherently antistatic behaviour. In the above-mentioned standardized walk tests, the tension is in the range of less than 1 kV.

As opposed to wool, Lyocell fibres are not infested by moths and therefore require no additional furnishing. Lyocell fibres can be dyed by techniques known per se for cellulose fibres and therefore render possible various colour variations.

Another favourable property of Lyocell fibres having a higher titre and a balanced ratio V is their higher flexural stiffness as compared to other cellulose fibres such as, for example, viscose.

Examples

In a continuously operating pilot plant for the manufacture of cellulose fibres of the Lyocell type, a cellulose solution having a cellulose content of about 13% (pulp manufacturer: Bacell) was spun through nozzles in a manner known per se and the final titre of the fibres was changed by adjusting the draft ratio (= drawing-off speed of the filament / nozzle-hole discharge speed, in each case in m/min).

In order to produce fibres with a titre of up to about 3.25, spinning was conducted through nozzle holes having a diameter of 100 μm; in order to produce fibres with a higher titre, spinning was conducted through nozzle holes having a diameter of 160 μm.

According to the „Testing methods viscose, modal, lyocell and acetate staple fibres and tows" as published by BISFA, the fibre strength in the conditioned state FFk (cN/tex) as well as the fibre elongation in the conditioned state FDk (%) were determined in each case from the obtained fibres.

From the values for FFk and FDk evaluated in this way, the ratio V was determined by dividing FFk (cN/tex) by FDk (%).

The following table 1 contains a summary of test parameters and obtained results.

**Table 1**

| Spinning mass cellulose (%) | Diameter nozzle [μm] | Draft ratio | Titre (dtex) | FFk (cN/tex) | FDk (%) | FFk absolute (cN/tex* dtex) | Ratio V (FFk / FDk) |
|---|---|---|---|---|---|---|---|
| 12.0 | 100 | 17 | 0.92 | 45.7 | 16.6 | 42 | 2.75 |
| 13.0 | 100 | 13 | 1.30 | 41 | 15.2 | 53 | 2.70 |
| 13.0 | 100 | 9 | 1.71 | 37.6 | 14.8 | 64 | 2.54 |
| 13.5 | 100 | 5 | 3.17 | 33.8 | 12.6 | 107 | 2.68 |

| Spinning mass cellulose (%) | Diameter nozzle [µm] | Draft ratio | Titre (dtex) | FFk (cN/tex) | FDk (%) | FFk absolute (cN/tex* dtex) | Ratio V (FFk / FDk) |
|---|---|---|---|---|---|---|---|
| 13.0 | 160 | 13 | 3.25 | 37.5 | 12.8 | 122 | 2.93 |
| 13.5 | 160 | 7 | 5.73 | 29.1 | 11.4 | 167 | 2.55 |
| 13.7 | 160 | 2.7 | 13.00 | 30.8 | 14.3 | 400 | 2.15 |
| 13.5 | 160 | 2.6 | 15.70 | 27.6 | 14 | 433 | 1.97 |
| 13.5 | 160 | 2.1 | 17.20 | 31.2 | 15.1 | 537 | 2.07 |
| 13.5 | 160 | 1.8 | 19.20 | 30.6 | 16.7 | 588 | 1.83 |

Table 1 makes evident that, as from a titre of 6 dtex, the ratio V assumes values of 2.2 or less.

This is also apparent in particular from Fig. 1 wherein the results are graphically represented in accordance with Table 1.

One reason for the decrease in the ratio V in case of higher fibre titres could be that the evaluated fibre elongation of the fibres decreases virtually linearly down to a titre of about 6 dtex but increases in case of higher titres.

This is illustrated in Fig. 2 wherein the absolute fibre strength „FFk absolute“ (FFk multiplied by the respective fibre titre) and the fibre elongation FDk are plotted against the fibre titre. Whereas the absolute fibre strength increases linearly with an increasing titre, the fibre elongation at first decreases with an increasing titre in order to rise again with higher titres.

Table 2 illustrates the high flexural stiffness of fibres of the Lyocell type as compared to viscose fibres.

The flexural stiffness is determined according to a method developed by the applicant. The measured value is indicated as a titre-based ratio of the gradient of force to path across a linear measuring range.

For implementation, a conditioned fibre is clamped horizontally into a clamping bar and is cut with a device to a length of exactly 5 mm. Via an electric drive, the clamping bar is

moved upward at a constant speed. In doing so, the fibre is pressed against a sensor plate which is adapted to a force transducer. The stiffer a fibre, the higher the measured force.

Due to a lack of calibration possibilities, no effective force is indicated for calculating the flexural stiffness. It is, however, possible to conduct a relative comparison of fibres within a certain measuring range. In doing so, the gradient in a linear measuring range of the measured force per path is calculated and related to the titre of the fibre.

**Table 2**

| | Bending gradient / dtex | |
|---|---|---|
| Titre (dtex) | Lyocell | Viscose |
| 1.3 | | 0.03 |
| 3.3 | 0.12 | 0.06 |
| 5.0 | | 0.11 |
| 6.7 | 0.22 | |
| 13.6 | 0.52 | |
| 17.0 | | 0.31 |